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It is a pleasure to appear before the Committee to discuss the vital mission of expanding and strengthening the Federal Government's investment in scientific discovery. Throughout my service in the Clinton Administration, especially as White House Chief of Staff, I had the privilege of being deeply involved in the development of budget and policy priorities in this area.

Today, as the nation is focused on fighting a war on terrorism and strengthening our homeland security, it is important to consider how our scientific research enterprise can not only help fulfill that mission but secure the blessing of liberty and improve the quality of life for all Americans.

Science has been on the frontlines and in the trenches of every campaign to protect America's freedom. Today's war against terrorism is no different. Watching the footage from Afghanistan, we realize that this war has not only been fought by American soldiers with guns in the caves of Tora Bora, but also by scientists in labs on American soil. We now live in a world where a commander in Tampa, Florida, watching a video screen, can unleash the fury of a Hellfire missile from an unmanned Predator flying low over enemy lines.

The events and consequences of September 11th have forced us to re-examine nearly every facet of American life. Our nation must revolutionize the way we approach national security, from bioterrorism to military readiness, to electronic surveillance and communications security. In his September 20th address before a joint session of Congress, the President stated, "Americans are asking: How will we fight and win this war? We will direct every resource at our command -- every tool of intelligence … every necessary weapon of war -- to the disruption and to the defeat of the global terror network." By framing technological innovation in the context of national survival, the President has profoundly affected the scope and the rules by which the pace of scientific inquiry will be conducted in the United States.

This is not the first time a President has called on the scientific community to meet the country's strategic goals. Forty years ago, in the midst of another national security crisis – the Cold War -- another President posed the same challenge. On September 12, 1962, President John F. Kennedy declared, "We meet in an hour of change and challenge, in a decade of hope and fear, in an age of both knowledge and ignorance …We choose to go the moon in this decade and do the other things, not because they are easy but because they are hard … because that challenge is one … we are unwilling to postpone, and one which we intend to win." Within a few years, America's scientists and engineers had risen to meet that challenge, and our nation won the race to the moon.

Kennedy's victory was part of a great American tradition of expanding the frontiers of innovation. More than a hundred and fifty years before Kennedy put a man on the moon, President Thomas Jefferson worked to put a man out West. At his behest, Lewis and Clark set out on a voyage of discovery -- a mission planned out on the tables of the East Room in the White House. There, Jefferson and Lewis

charted the journey that would not only map the contours of our continent, but expand forever the frontiers of our national imagination. They were the forebearers of those who have given us the Mars expedition, an international space station, and a map of the human genome.

From the great frontier to the new frontier, all these discoveries have had a common dominator: the drive, determination and dollars of the federal government. Without Jefferson's encouragement and Kennedy's imagination, America would be a lesser nation. For generations, our leaders have recognized that without government funding for scientific and technological advancement, America would never be a global pioneer in the labs and classrooms – and certainly not a world leader in health care, education, the environment, transportation, finance or national security.

Many of the products and services we have come to depend on – from lasers to communication satellites to human insulin – are the direct result of policies designed to bolster science and technological advancement. Government dollars used for polio eradication, AIDS treatment, and the mapping of the human genome have helped Americans live longer, healthier lives. In the last century alone, the average life expectancy in the United States has increased by nearly 30 years – from 47 to 76.

In national security, federal dollars helped build the atomic bomb, stealth aircraft, and unmanned surveillance drones. In environmental science, thanks to federal investment, manufacturing processes that emit zero waste and fuel cars that get the equivalent of 80 miles per gallon are well within our reach. These advances have fueled our remarkable economic prosperity; since World War II, innovation has been responsible for nearly half of our national economic growth.

While it is clear government funding has been critical for the advancement of science, there is considerable debate as to how government funds for scientific research should be allocated.

President Clinton, from the first days of his campaign, viewed science – including biotechnology, information technology and physical sciences – as a core element of his economic policy. I served in an administration that believed that federal investment in technology and human capital would be the driving force behind an economic renewal. Vice-President Al Gore, who has been one of Congress's foremost experts in science policy, strengthened the Clinton Administration's and especially the White House's involvement in science policy.

Before commenting on the Bush Administration's budget, it is worth noting five features of the Clinton-Gore approach to science policy.

First, the Administration brought development of science policy firmly under the grip of the White House. President Clinton established the National Science and Technology Council (E.O. 12281, November 1993), the first cabinet-level council charged with oversight of the federal investment in science and technology. The Council along with the OSTP/OMB annual interagency R&D budget guidance, which established interagency R&D priorities for each fiscal year, reinforced the decision to invest in science and technology even as other spending was cut to eliminate the budget deficit. The President increased R&D spending in each of his eight years in office.

Second, recognizing the demand for greater accountability of scientific research to public officials and private citizens, Clinton took several steps to strengthen oversight of science policymaking. In 1993, he established the President's Committee of Advisors on Science and Technology (E.O. 12882), an advisory board comprised of individuals from industry, education, research institutions, and other nongovernmental organizations. In 1995, the President established the National Bioethics Advisory Commission (E.O. 12975) to ensure the ethical conduct of human biological and behavioral research and

to help the Administration address policy issues pertaining to cloning and stem cell research.

Third, the President sought to connect government-funded research to broad, definable national goals. Examples include the Next Generation Internet initiative, a project designed to invest in R&D for new networking technologies at speeds that are 1,000 times faster than the then existing Internet; the Information Technology for the Twenty-First Century (IT^2) Initiative, a multi-agency initiative focused on fundamental research in software, development of information systems that ensure privacy and security of data; the National Nanotechnology Initiative to accelerate development and deployment of nanotechnology in areas such as materials and manufacturing, nanoelectronics, medicine and healthcare, environment, energy, chemicals, biotechnology, agriculture, information technology, and national security; a National Plant Genome Initiative (NPGI) that supports the sequencing of the genomes of model organisms, including *Arabidopsis thaliana* and an international effort to fully sequence the rice genome; and of course the Human Genome Project.

Fourth, the Clinton Administration understood that an increasing share of the nation's R&D budget was coming from the private sector. The Administration sought to harness this private investment for public ends by establishing a series of public-private partnerships, formalizing coordination between corporations, universities and government. Examples included Partnership for a New Generation of Vehicles (PNGV), to produce the technology for lighter, more fuel-efficient vehicles and the Partnership Advancing Technology in Housing, to spur the development and use of advanced technologies to radically improve the quality, energy efficiency, environmental performance and affordability of the nation's housing. The Clinton Administration also took steps to encourage direct private investment in research and development through patent reform, and R&D tax credit, and programs to bridge the digital divide.

Finally, President Clinton recognized the critical importance of investment in the education of tomorrow's scientists. He significantly increased the funding for science and engineering programs and research at America's universities; the Department of Education and the Department of Defense, for example, earmarked millions for university research. Educating students is directly related to his larger objective of improving the basic scientific literacy of all citizens.

The Bush Administration has, for the most part, built on the Clinton Administration's strong support for Federal R&D. Their FY 2003 Budget proposes an increase for Federal R&D of almost 9 percent or $8.9 billion over FY 2002 levels, bringing R&D funding to a record $112 billion. Notably, the rate of increase for R&D would significantly exceed the overall 6.8 percent increase proposed for overall discretionary spending. Increases would be targeted to defense, the war on terrorism and health and the commitment made by the Clinton Administration and the Congress to double NIH funding between 1998 and 2003 would be completed.

President Bush also continued the President's Committee of Advisors on Science and Technology, albeit with a heavier focus on industry participants rather than leading University-based scientists, and reconstituted the National Bioethics Advisory Commission. His budget continues research initiatives on Nanotechnology and Networking, and Information Technology, and added a new initiative on Anti-terrorism R&D.

The proposed funding increases for the FY 2003 budget for the DOD and NIH are laudable, especially in light of the transformative events of the past year. Those additional funds will aid the development of new technologies to fight the war on terrorism, help fend off future biological attacks and accelerate the process of discovering new treatments for cancer, AIDS and other illnesses.

Nevertheless, the research and development funding in the FY 2003 budget falls short of its potential. While the overall research and development budget has increased, these funds are directed almost exclusively into the NIH and the DOD. Excluding the NIH, non-defense research and development spending is reduced by 0.2%, with many critical programs facing far deeper cuts. By failing to provide adequate funding across scientific disciplines, the budget threatens many key priorities.

Double the NSF Budget

First, the budget fails to adequately support the NSF and threatens the quality basic research conducted at colleges and universities. Discounting the funds allocated as the result of transferring three programs to the NSF from other agencies, the NSF budget is increased a mere 3.4%, barely keeping pace with inflation. The NSF is a model government agency. It performs its job funding university research and other educational programs with unrivaled efficiency. It is the only government agency to receive a "green light" in financial management from the GAO and the OMB. All other government agencies received either a yellow or red light. Moreover, the NSF is the only federal agency with responsibility for research and education is all major scientific disciplines. The basic research conducted with NSF funds is the foundation for all future R&D. A strong commitment to the NSF is essential to a broad-based commitment to research and development.

The NSF's support for the science and technology research across all disciplines is crucial as the science becomes more complex and inter-related. For example, advances in medical care responsible for increasing American's life span could not have occurred without the underlying knowledge in the physical sciences. Magnetic resonance imaging, ultrasound, laser surgery, and artificial joints and valves, which today we take for granted, were only developed with support from physicist, chemists, mathematicians, computer scientists, and engineers. Also, it is impossible to predict where the next scientific discovery that will drive our Nation's economic growth or protect our national security will occur. For example, today's discoveries in the field of nanotechnology are being used in the automotive, apparel, and cosmetic industries in ways those industries could never have foreseen just a few years ago. Finally, we need to be concerned about training the right mix of scientists and engineers, and other scholars to meet our economic and national security needs of the next generation.

The NSF has an extraordinary impact on American scientific discovery. Eight of the last 12 American Nobel Prize winners were supported by the NSF at some point in their careers. The NSF also plays a crucial role in supporting university-based research, funding roughly 50 percent of all non-medical basic research at colleges and universities. The discoveries from these labs benefit us today and the scientists trained in them will benefit us into the future. I believe doubling the NSF's budget will strengthen our Nation's economy and security by providing support for advancements in science and technology research across all disciplines.

A Manhattan Project for Energy Security

Second, the budget fails to address the nation's needs in creating energy security. Our dependence on fossil fuels is not only a serious environmental problem but also a critical national security problem.

Today we are importing 52% of our oil, 25% from the Persian Gulf, 16% from the Saudi Arabia alone. Imports are projected to rise to 64% by 2020. That figure would only be reduced to 62% if we did everything contained in the President's energy plan or the recently passed Senate Energy bill. Europe and Japan are even more dependent on Middle East oil. China is the fastest growing importer, which is

important, if for no other reason than the proliferation problems that will be presented if China becomes dependent on oil from Iran and Iraq.

Less well appreciated are the real national security concerns that will result from global warming pollution. The question is no longer will the atmosphere warm but by how much. Even at the lowest end of climate models that assume rapid cuts in emissions, scientists predict at least a 2.5 degree Fahrenheit increase in global temperature over the next century. Contrast that with the less than 1-degree increase over the last millennium, and you can begin to appreciate the scope of the problem. It is a problem that threatens the security of the world's fresh water supplies and the production of agricultural products around the world. It is a problem that could create an astronomical number of environmental refugees from the Middle East to Bangladesh and Indonesia to Central America. Despite these dangers, this Congress and this Administration do not seem likely to act forcefully to mandate reductions in CO2 emissions. Research and Development seems to be the one area where there is a possibility that Congress and the Administration could agree to take precautionary action to stave off the effects of global warming. The scope of the problem calls for an effort on the scale of the Manhattan Project -- massive investments for research and development in new technologies that could reduce CO2 emissions.

Unfortunately, such funding is not present in the FY 2003 budget. The FY 2003 budget decreases funding for energy conservation by 10.9%. These programs have proven to be an extraordinarily effective way to reduce our energy consumption and, as a corollary, our dependence on foreign oil. A DOE study found that twenty of its energy efficiency and renewable energy technologies have already saved the nation 5.5 quadrillion BTUs of energy over the last two decades, the equivalent to the amount of energy needed to heat every household in the U.S. for about a year. The cost to taxpayers for these 20 activities was $712 million, less than 3 percent of the energy bill savings to date.

Funding for renewable energy, while nominally increased over the previous year, has been shifted into the FreedomCar initiative, a laudable research program, but one that will take many years to yield results. Meanwhile, funding for the New Generation Vehicle program, which could enhance fuel efficiency immediately, has been eliminated. While wind-power research receives a small increase, research for biomass, geothermal and solar energy are all reduced by two to three percent. A budget with a broad based research commitment to energy conservation and alternative fuels would support a cleaner, healthier and more secure nation.

Resist the Temptation to Earmark Research and Development Funding

The Bush Administration has launched a major effort to reduce the amount of research and development funding that is earmarked to specific institutions. While that effort may not be popular on Capitol Hill, I want to go on record in support of the Bush Administration's position in this area. Research and development funding should be allocated through the peer-review system, which awards grants competitively. Earmarking funds politicizes scientific research and development. It creates an opportunity for institutions to be funded, outside the competitive process, not for the scientific merit of their proposals but for their connections to influential members of Congress. There are already many promising peer-reviewed proposals that are unable to be funded due to limited resources. Earmarking only creates further reductions in the amount of funding available for such higher-priority projects. As budgets tighten, the temptation for Congress to earmark funds increases. Congress does have the right and responsibility to set priorities for Science agencies. But in order to ensure our nations receives the maxim benefit from federal research dollars, Congress should resist the temptation to earmark funding for specific projects.

The NSF has traditionally been a safe haven from Congressional earmarking. It is essential that this remain the case. Universities and colleges should be focusing their energy on creating better research not lobbying the Congress for funds. Funding should be given to those institutions with the best proposals not the best connections.

Restore the Congressional Office of Technology Assessment

As the pendulum shifts away from a system that emphasizes research that explores scientific possibilities to one focused on near term R&D needs (from cybersecurity to national missile defense, to new surveillance technologies, to vaccine research), we still don't have adequate metrics or oversight mechanisms that measure outcomes.

We are good at measuring inputs (dollars requested, dollars appropriated to specific federal R&D accounts, doubling NIH funds); for the most part, we successfully measure outputs (DOD-ARPA/supported research that helped invent the Internet) and only rarely reflect on outcomes (11,000 additional cancer deaths per year as a result of above ground nuclear testing in the1950's and early 1960's).

While many individuals, institutions and agencies have an interest in touting individual success stories, no body or oversight institution has a vested interest in reviewing and reporting to the public on the overall trends in public scientific investment, the rates of return in public goods, the costs to the public from increased regulatory activity or from cleaning up spectacular failures.

The closest that the federal government ever came to institutionalizing an oversight mechanism useful to federal decision makers was the Congressional Office of Technology Assessment. That office conducted important, comprehensive studies on complicated issues years before they came to the national forefront. It was widely admired around the globe. Indeed Britain, France, Denmark, the Netherlands, the EU, the OECD and the UN have created agencies modeled after the OTA. Unfortunately, the OTA fell victim to the budget-cutting ax in 1995. It is important that Congress have access to objective analysis of competing points of view on important scientific questions and research opportunities. Re-creation of the OTA, run, as in the past, by a strong bipartisan board would be a giant step in the right direction.

Support Scientific Freedom and Openness

Not since our earliest days of the Cold War have we been faced with the question of the balance between scientific freedom and openness and the needs of national security and public safety. We are confronted today with an enemy that operates in the shadows, that will not only tolerate but target civilian casualties and has, at least, expressed an interest in acquiring the know-how to obtain weapons of mass destruction.

How then, does the scientific community react to this new threat?

It is clear that the Bush Administration has a strong policy preference for tilting the balance in favor of secrecy; for withholding government generated information that may in any way pose a threat if used by our adversaries; for encouraging public institutions and quasi-public institutions, including universities to self-sensor; to remove publicly useful information from government web sites; to carry out research through the Department of Defense and Energy's black programs; to keep foreign students from studying "sensitive" academic subjects; to provide original classification authority to the Department of Health and Human Services, which will complicate the flow of public health information between the federal government and State and local authorities. In sum, we are well on our way to re-establishing the

culture of secrecy across many sciences and disciplines, including biology, which was characteristic of the cold war approach to nuclear weapons, satellite imagery and cryptographic research.

At a very minimum, a trend which took root under Vice President Gore's leadership during the Clinton Administration to make scientifically valuable, but formerly classified data publicly available has come to a halt. For example, in 1995, for the first time, the overhead imageries from the Corona, Argon and Lanyard intelligence satellite missions were declassified – historic documents that will be of great value to scholars, as well as to the natural resource and environmental communities. Today the Department of Defense is buying up all commercial satellite imagery and older overhead imagery is being withheld from the public.

In 1998, undersea military data originally gathered to track enemy submarines was declassified and released to help researchers track marine mammals, predict deadly storms, detect illegal fishing, and gain new insights in to the complexities of climate change. The fate of that program is also in doubt.

This new culture of secrecy is bound to influence the direction of discovery, the efficient advancement of scientific knowledge, and the public's, or at least their representatives in Congress', opportunity to assess the costs that come from a science program unchecked by public scrutiny. Before we rush headlong into this new era of scientific secrecy, we should pause to remember the nuclear-exposure experiments carried out in this country on human subjects, including the mentally retarded and even children, and remember also, that the Ames strain of anthrax that was used in the attacks last fall was probably developed in a classified military program, ostensibly for defensive purposes.

Public knowledge, public scrutiny with free exchange of scientific information may not only provide the basis to make the breakthroughs necessary to stay ahead of our adversaries, but may provide a better long-term security paradigm as well. As National Academy of Sciences President Bruce Alberts recently noted, "Some of the planning being proposed (on restrictions of scientific publication) could severely hamper the U.S. research enterprise and decrease national security."

While we must always be mindful of the fact that there are secrets worth protecting, only strong Congressional support for scientific freedom with a vigorous program of Congressional oversight will keep us from slipping back into a culture of secrecy which will not only slow the advancement of science in general, but will also hobble our ability to develop new technologies to secure our nation.

Conclusion

There is much in the 2003 R&D budget that can be commended. Overall spending increases, continuing the Clinton administration's strong support of the scientific research. There is strong support for the health sciences and national security, which are unquestionably high-priority areas. Nevertheless, there is room for improvement. Adequate funding should be provided over a broader range of scientific disciplines. The NSF should be more strongly supported. Increased funding should be provided to create energy security and reduce global warming. Further, the government should assess technological outcomes and, as much as possible, make those outcomes public. These suggestions would allow federal monies to more fully harness the efforts and ingenuity of the scientific community for the common good.